IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

JC790 U.S. PTO
09/761249
01/16/01

In re Application of	Atty. Docket
YANN LE MAGUET	FR 000039
Serial No.	Group Art Unit
Filed: CONCURRENTLY	Ex.

Title: PIXEL-BASED DATA MODIFYING METHOD AND DEVICE
Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

AUTHORIZATION PURSUANT TO 37 CFR §1.136(a)(3) AND TO CHARGE DEPOSIT ACCOUNT

Sir:

The Commissioner is hereby requested and authorized to treat any concurrent or future reply in this application requiring a petition for extension of time for its timely submission, as incorporating a petition for extension of time for the appropriate length of time.

Please charge any additional fees which may now or in the future be required in this application, including extension of time fees, but excluding the issue fee unless explicitly requested to do so, and credit any overpayment, to Deposit Account No. 14-1270.

Respectfully submitted,

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Bescheinigung | Certificate | Attestation

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The attached documents are exact copies of the European patent application described on the following page, as originally filed.

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Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

00400101.2

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
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Blatt 2 der Bescheinigung
Sheet 2 of the certificate
Page 2 de l'attestation

Anmeldung Nr.:
Application no.: 00400101.2
Demande n°:

Anmeldetag:
Date of filing: 14/01/00
Date de dépôt:

Anmelder:
Applicant(s):
Demandeur(s):
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5621 BA Eindhoven
NETHERLANDS

Bezeichnung der Erfindung:
Title of the invention:
Titre de l'invention:
Method and device for modifying data in an encoded data stream

In Anspruch genommene Prioriät(en) / Priority(ies) claimed / Priorité(s) revendiquée(s)

Staat: State: Pays:	Tag: Date: Date:	Aktenzeichen: File no. Numéro de dépôt:

Internationale Patentklassifikation:
International Patent classification:
Classification internationale des brevets:
/

Am Anmeldetag benannte Vertragstaaten:
Contracting states designated at date of filing: AT/BE/CH/CY/DE/DK/ES/FI/FR/GB/GR/IE/IT/LI/LU/MC/NL/PT/SE/TR
Etats contractants désignés lors du depôt:

Bemerkungen:
Remarks:
Remarques:

« METHOD AND DEVICE FOR MODIFYING DATA IN AN ENCODED DATA STREAM »

FIELD OF THE INVENTION

The present invention relates to a method of modifying data in an encoded data stream corresponding to successive pictures divided into sub-pictures, comprising the steps of :

- decoding said encoded data stream ;
- re-encoding the decoded data stream.

The invention also relates to a video processing device for carrying out said method. This invention, for instance useful when a broadcaster wants to introduce additional data such as its own logo into a sequence of pictures, finds applications not only in the field of MPEG-2 compression (MPEG-2 will be the common standard for TV broadcasting), but more generally in any digital video data compression system.

BACKGROUND OF THE INVENTION

In such a situation, i.e.when additional digital data have to be added before transmission to an existing coded bitstream, the simplest solution is to decode said bitstream before carrying out said addition. The modified bitstream is then re-encoded and transmitted. Unfortunately, a full decoding can generally be considered as expensive, as it requires a decoder and an encoder. Moreover, re-encoding with re-estimated modes and vectors may introduce artefacts on the areas left untouched by the logo addition.

A less expensive solution has then been proposed in the international patent application W0 99/51033 (PHF98546). Before describing this solution, some information is first recalled concerning conventional video decoders and encoders.

A conventional video decoder such as shown in Fig.1 includes a decoding channel 12, which comprises in cascade a variable length decoding circuit 1, an inverse quantizing circuit 2 and an inverse frequency transform circuit 3 (respectively : VLD, IQ, IDCT), and a motion compensation channel 14, which comprises a picture memory 4 receiving the output signals of the decoder, a motion compensation circuit 5 (said compensation taking into account the output signals of this memory 4 and motion vectors V(n) received by the decoder) and an adder 6 of the output signals of circuits 3 and 5 (respectively : MEM, COMP, A). The output picture of the decoder (also sent to the picture memory 4) is reconstructed by adding the prediction (output of circuit 5) to the decoded residual signal available at the output of the circuit 3 of the decoding channel 12.

A conventional video encoder such as shown in Fig.2 includes an encoding and decoding channel 13, which comprises a discrete cosine transform circuit 25, a quantizing circuit 26, a variable length coding circuit 27 (respectively : DCT, Q, VLC) and,

at the output of the circuit 26, in cascade, an inverse quantizing circuit 28 and an inverse discrete cosine transform circuit 29 (respectively : IQ and IDCT), and a prediction channel 11, allowing to subtract a motion compensated prediction from the input signal and which comprises an adder 21, for the reconstruction of the pictures before prediction, a picture memory 22, a motion compensation circuit 23 and a subtracter 24 (respectively : A, MEM, COMP, S). Said compensation takes into account previously estimated motion vectors V(n).

A possible method and a device allowing to add data such as a logo to an incoming bitstream in a transmission chain are illustrated in Fig.3. Said chain comprises a first encoder 31 (called "encoder 1"), a sub-system 305 for the addition of the logo to the coded bitstream available at the output of the encoder 31, and, after transmission, a decoder 35 ("decoder 2"). The sub-system provided between said encoder and decoder itself comprises, as illustrated, a decoder 32 ("decoder 1"), a logo adder 33 and an encoder 34 ("encoder 2"). Then, starting from said decoder 32 and said encoder 34 and taking advantage of their complementarity, some simplifications are made, in order to finally reach the outline of the transcoder according to the cited document.

According to Fig.2, one has indeed, for the first encoder 31 :

$$R(n,1) = I(n) - P(I'(n-1), 1 ; V(n)) \qquad (1)$$

where the index (,1) in R(.) and P(.) designates the "first" encoder 31 (= encoder 1), I(n) is the original video input of the encoder, P(I'(n-1), 1 ; V(n)) is the prediction signal computed by applying motion vector V(n) to the previously "decoded" picture I'(n-1) and which has to be subtracted from the original input bitstream I(n) in order to obtain the residual signal R(n) to be coded, and R(n) designates this residual signal. It must be noted that the signal R'(n) available at the input of the prediction channel of the encoder differs from R(n) by a value e(n) called the coding error ; R'(n) being equal to R(n) + e(n), the signal at the output of the adder of this prediction channel is therefore I'(n) = I(n) + e(n).

For the first decoder 32 that follows the encoder 31, one has similarly, according to Fig.1 :

$$I'(n,1) = R'(n,1) + P(I'(n-1), 1 ; V(n)) \qquad (2)$$

where the index (,1) in I'(.), R'(.) and P(.) designates the "first" decoder 32, R'(n) is the decoded residual signal, P(I'(n-1), 1 ; V(n)) is the prediction to be added to R'(n), and I'(n) designates the output of the decoder. As seen above, I'(n,1) may also be written in the form :

$$I'(n,1) = I(n) + e(n,1)$$

that is to say, the output of the decoder is the sum of the original input signal I(n) and of the coding error e(n) during the coding operation of I(n). At the output of the logo adder 33, one has consequently :

$$J'(n,1)=I'(n,1)+Logo(n) \quad (3)$$

where I'(n) is the output of the decoder 32 and Logo(n) the data (for instance, a logo) to be added to the main bitstream. The resulting output J'(n) is sent towards the encoder 34.

For this second encoder 34, one has (similarly to the previous case of the first encoder 31) :

$$R(n,2) = J'(n,1) - P(J'(n-1), 2 ; V(n)) \quad (4)$$

where the index (,2) in R(.) and P(.) now designates this "second" encoder 34, P(J'(n-1),2 ; V(n)) is the prediction which has to be subtracted from the output J'(n-1) of the logo adder 33 in order to obtain the residual signal that has to be coded, and R(n) designates said residual signal.

Finally, for the second decoder 35, one has (similarly to the previous case of the first decoder 32) :

$$J'(n,2) = R'(n,2) + P(J'(n-1), 2 ; V(n)) \quad (5)$$

where the index (,2) in J'(.), R'(.) and P(.) now designates this "second" decoder 35, R'(n) is the decoded residual signal, P(J'(n-1), 2 ; V(n)) is the prediction to be added to R'(n), and J'(n) designates the output of the decoder. As for the decoder 32, J'(n,2) may be also be written in the form :

$$J'(n,2) = J'(n,1) + e(n,2)$$
$$J'(n,2) = I'(n,1) + Logo(n) + e(n,2)$$
$$J'(n,2) = I(n) + e(n,1) + Logo(n) + e(n,2) \quad (6)$$

which means that the output signal J'(n,2) of the transmission chain is indeed equal to the sum of the original input signal I(n), of the first coding error (coding/decoding in the first encoder and decoder), of the second coding error (coding/decoding in the second encoder and decoder), and of the additional data.

Then, using the linearity of the motion compensation operator, it may be written :

$$P(J'(n-1), 2 ; V(n)) = P[((J'(n-1), 1) + (e(n-1), 2)) ; V(n)] \quad (7)$$

which allows to write the relation (4) in the form :

$$R(n,2) = J'(n,1) - P[((J'(n-1), 1) + (e(n-1), 2)) ; V(n)] \quad (8)$$

Using again the linearity of the compensation operator, one has :

$$P(J'(n-1), 1 ; V(n)) = P[(I'(n-1) + Logo(n-1)), 1 ; V(n)]$$

or :

$$P(J'(n-1), 1 ; V(n)) = P(I'(n-1), 1 ; V(n)) + P(Logo(n-1), 1 ; V(n)) \quad (9)$$

Therefore the relation (8) becomes :

$$R(n,2) = I'(n,1) + Logo(n) - P(e(n-1),2 ; V(n))$$
$$- P(I'(n-1), 1 ; V(n)) - P(Logo(n-1), 1 ; V(n)) \quad (10)$$

or, from the relation (2) :

$$R(n,2) = R'(n-1) - P(e(n-1), 2 ; V(n)) + Logo(n) - P(e(n-1),2 ; V(n)) - P(I'(n-1), 1 ; V(n)) - P(Logo(n-1), 1 ; V(n)) \quad (11)$$

which finally leads to the following relation (12) :

$$R(n,2) = R'(n-1) - P(e(n-1), 2 ; V(n)) + Logo(n) - P(Logo(n-1) ; V(n)) \quad (12)$$

which is the final system equation of the transcoder with logo adder as proposed in the cited document.

The general outline of a transcoder without logo adder is first recalled in Fig.4. It comprises a residue decoding branch 41 (variable length decoding VLD + inverse quantization IQ + inverse discrete cosine transform IDCT), an encoding and decoding branch 42 (discrete cosine transform DCT + quantization Q + variable length coding VLC ; inverse quantization IQ + inverse discrete cosine transform IDCT), and an intermediary branch called a pseudo-prediction branch 43 (first subtracter S + memory MEM + motion compensation COMP on the basis of motion vectors V(n) + second subtracter S). This branch 43 is so called because it is not exactly a classical prediction as in a basic encoder, the first adder being here replaced by a subtracter. The signals R'(n,1), R(n,2), R'(n,2), e(n,2), V(n), P(e(n-1), 2 ; V(n)) previously cited are shown in Fig.4.

The corresponding scheme of the transcoder according to the cited document –i.e. with a logo adder- is then illustrated in Fig.5 where, in comparison with Fig.4, the identical parts are designated in the same manner. The additional part is a logo addition branch 50 that includes a memory MEM 51, receiving the logo to be added (signal Logo(n)), a motion compensation circuit COMP 52, receiving the output of the memory 51 and the vectors V(n) and delivering a predicted data stream, a subtracter S 53, for delivering the difference between the original signal Logo(n) and the motion compensated one P(Logo(n-1) ; V(n)) available at the output of the circuit 52 (predicted data stream), and an adder 54, for introducing the output signal of said subtracter 53 into the main bitstream (corresponding to the complete sequence of successive pictures). The logo addition is therefore implemented by means of a residue addition to the incoming bitstream, and this residue is formed by subtracting logo with a motion compensated logo prediction that is based on reference pictures containing logo previously stored and that uses the same modes and vectors as the main incoming bitstream.

The method and device thus described (Fig.5) are an improvement with respect to the conventional solution in which the input stream is completely decoded, an addition of data is performed in the pixel domain, and the resulting video sequence is re-encoded (Fig.3). However, in this scheme of Fig.5, two motion compensations are performed : a first one, well known and provided for correcting the quality drift introduced by the quantization function, and a second one on the data to be added, in

order to be able to keep, in the output stream, the motion characteristics (motion types, motion vectors,...) of the input stream. With these two motion compensation operations and the three DCT or IDCT blocks, this solution remains still complex.

SUMMARY OF THE INVENTION

It is therefore a first object of the invention to propose, with respect to the solution previously described for adding data to a previously existing coded bitstream, a further improvement, leading to a reduced complexity.

To this end, the invention relates to a method of modifying data in an encoded data stream corresponding to successive pictures, which method comprises a decoding step of the input digital signals which are associated with each current picture, a re-encoding step, and, between said decoding and re-encoding steps, a prediction step comprising in cascade at least :

(a) a first subtracting sub-step provided for determining an encoding error during said re-encoding step ;

(b) a motion compensation sub-step between said current picture and a previous picture ;

(c) a second subtracting sub-step between the decoded signals obtained after said decoding step and the motion-compensated signals obtained after said motion compensation sub-step, the output of said second subtracting sub-step corresponding to the input of said re-encoding step ;

characterized in that it also comprises :

(d) between said decoding step and said second subtracting sub-step, a first adding sub-step ;

(e) between said first subtracting and motion compensation sub-steps, a second adding sub-step ;

said modifying data being simultaneously introduced in the decoded input signal by means of said first adding sub-step and before motion compensation by means of said second adding sub-step.

According to another embodiment, the invention relates to a method of modifying data in an encoded data stream to successive pictures, which method comprises a decoding step of the input digital signals which are associated with each current picture, a re-encoding step, and, between said decoding and re-encoding steps, a prediction step comprising in cascade at least :

(a) a first subtracting sub-step provided for determining an encoding error during said encoding step ;

(b) a first sub-step for converting frequential signals into spatial signals ;

(c) a motion compensation sub-step between the current picture and a previous picture ;

(d) a second sub-step for converting spatial signals into frequential signals ;

(e) a second subtracting sub-step between the decoded signals obtained after said decoding step and the signals obtained after said second converting sub-step, the output of said second subtracting sub-step corresponding to the input of said re-encoding step ;

characterized in that it also comprises :

(f) between said decoding step and said second subtracting sub-step, a first adding sub-step ;

(g) between said first subtracting sub-step and said first converting sub-step, a second adding sub-step ;

said modifying data being simultaneously introduced in the decoded input signal by means of said first adding sub-step and before said first converting sub-step by means of said second adding sub-step.

Another object of the invention is to still simplify said method, especially for consumer applications.

To this end, the invention relates to a method of modifying data in an encoded data stream corresponding to successive pictures, which method comprises a decoding step of the input digital signals which are associated with each current picture, and a re-encoding step,

characterized in that it also comprises an addition step for defining :

(i) on the basis of these additional data and motion vectors previously defined, a predicted signal ;

(ii) the difference between said additional data and said predicted signal, in view of an addition of said difference into said data stream between decoding and re-encoding parts.

Another object of the invention is to propose video processing devices for adding data to a video coded data stream according to anyone of these three implementations of the method according to the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiment described hereinafter.

In the drawings :

- Figs.1 and 2 show conventional video decoder and encoder ;

- Fig.3 shows a possible scheme of a transmission chain for adding a logo to an incoming bitstream ;

- Fig.4 illustrates the outline of a known transcoder, without logo adder ;
- Fig.5 illustrates such a transcoder when it is, according to the solution described in the previously cited document, provided with a logo adder ;
- Figs.6 to 8 illustrate three embodiments of the technical solution according to the present invention.

DESCRIPTION OF THE INVENTION

Since the two motion compensation operations in Fig.5 use the same motion vectors (i.e. the motion vectors of the input stream), and since a motion compensation can be considered as linear, it is possible to merge them, which leads to the simplified scheme depicted in Fig.6. In this first embodiment of the invention, three IDCT or DCT are applied on all the 8 x 8 pixels blocks of the input pictures.

Since the DCT and IDCT are also linear, and since applying an IDCT to a signal that has passed through a DCT equals a unity transfer, the data adder can be simplified to obtain the scheme depicted in Fig.7. In this second embodiment of the invention, there are still three IDCT or DCT, but the DCT applied on the data is only performed where data have to be added : for example, if a logo is inserted, then the DCT is performed only on the picture area where the logo is put.

These two simplified schemes of Figs.6 and 7 are equivalent, in terms of picture quality, to Fig.5. A third embodiment of the invention may then be proposed, in which it is decided not to correct the quality drift that occurs because of the quantization function, which leads to the scheme depicted in Fig.8. In this scheme, the addition of the data is performed in the DCT domain (and not in the pixel domain) and the coding loop of Fig.5 (IQ->IDCT->MEM->COMP->DCT) has been suppressed. This solution, which introduces some quality drift compared to solutions of Figs.6 and 7, is however of high interest since it requires far less processing : DCT/IDCT blocks and motion compensation blocks have been suppressed.

CLAIMS :

1. A method of modifying data in an encoded data stream corresponding to successive pictures, which method comprises a decoding step of the input digital signals which are associated with each current picture, a re-encoding step, and, between said decoding and re-encoding steps, a prediction step comprising in cascade at least :

(a) a first subtracting sub-step provided for determining an encoding error during said re-encoding step ;

(b) a motion compensation sub-step between said current picture and a previous picture ;

(c) a second subtracting sub-step between the decoded signals obtained after said decoding step and the motion-compensated signals obtained after said motion compensation sub-step, the output of said second subtracting sub-step corresponding to the input of said re-encoding step ;

characterized in that it also comprises :

(d) between said decoding step and said second subtracting sub-step, a first adding sub-step ;

(e) between said first subtracting and motion compensation sub-steps, a second adding sub-step ;

said modifying data being simultaneously introduced in the decoded input signal by means of said first adding sub-step and before motion compensation by means of said second adding sub-step.

2. A method of modifying data in an encoded data stream to successive pictures, which method comprises a decoding step of the input digital signals which are associated with each current picture, a re-encoding step, and between said decoding and re-encoding steps, a prediction step comprising in cascade at least :

(a) a first subtracting sub-step provided for determining an encoding error during said re-encoding step ;

(b) a first sub-step for converting frequential signals into spatial signals ;

(c) a motion compensation sub-step between the current picture and a previous picture ;

(d) a second sub-step for converting spatial signals into frequential signals ;

(e) a second subtracting sub-step between the decoded signals obtained after said decoding step and the signals obtained after said second converting sub-step, the output of said second subtracting sub-step corresponding to the input of said re-encoding step ;

characterized in that it also comprises :

(f) between said decoding step and said second subtracting sub-step, a first adding sub-step ;

(g) between said first subtracting sub-step and said first converting sub-step, a second adding sub-step ;
said modifying data being simultaneously introduced in the decoded input signal by means of said first adding sub-step and before said first converting sub-step by means of said second adding sub-step.

3. A method of modifying data in an encoded data stream corresponding to successive pictures, which method comprises a decoding step of the input digital signals which are associated with each current picture, and a re-encoding step, characterized in that it also comprises an addition step for defining :

(i) on the basis of these additional data and motion vectors previously defined, a predicted signal ;

(ii) the difference between said additional data and said predicted signal, in view of an addition of said difference into said data stream between decoding and re-encoding parts.

4. A video processing device for adding data to a video coded data stream, carrying out the method according to anyone of claims 1 to 3.

Abstract

The invention relates to a method of modifying data in an encoded data stream corresponding to successive pictures, which method comprises a decoding step of the input digital signals which are associated with each current picture, followed by an encoding step. According to a main embodiment of the invention, the modifying data are simultaneously introduced in the decoded input signal by means of a first adding sub-step and in a prediction loop by means of a second adding sub-step.

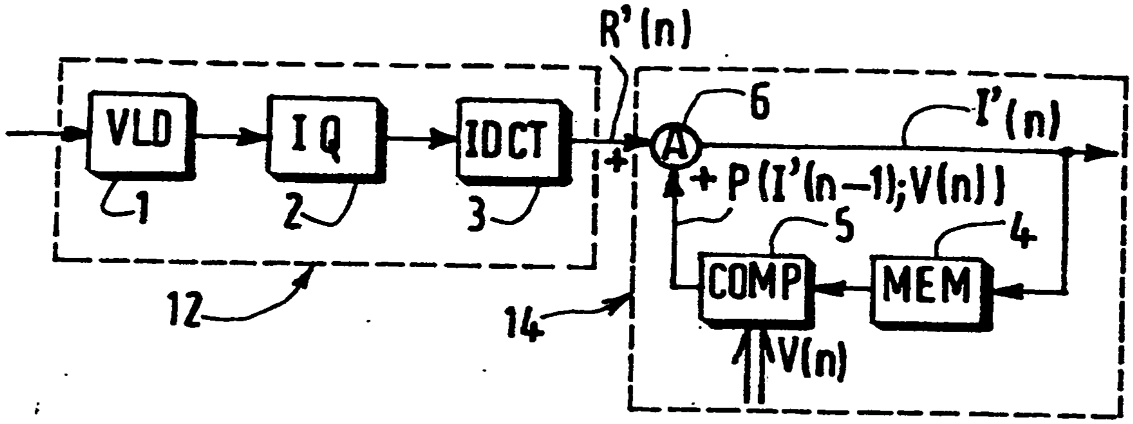

R'(n)
VLD
IQ
IDCT
1
2
3
12
6
I'(n)
+
+ P (I'(n–1);V(n))
5
4
COMP
MEM
V(n)
14

FIG.1

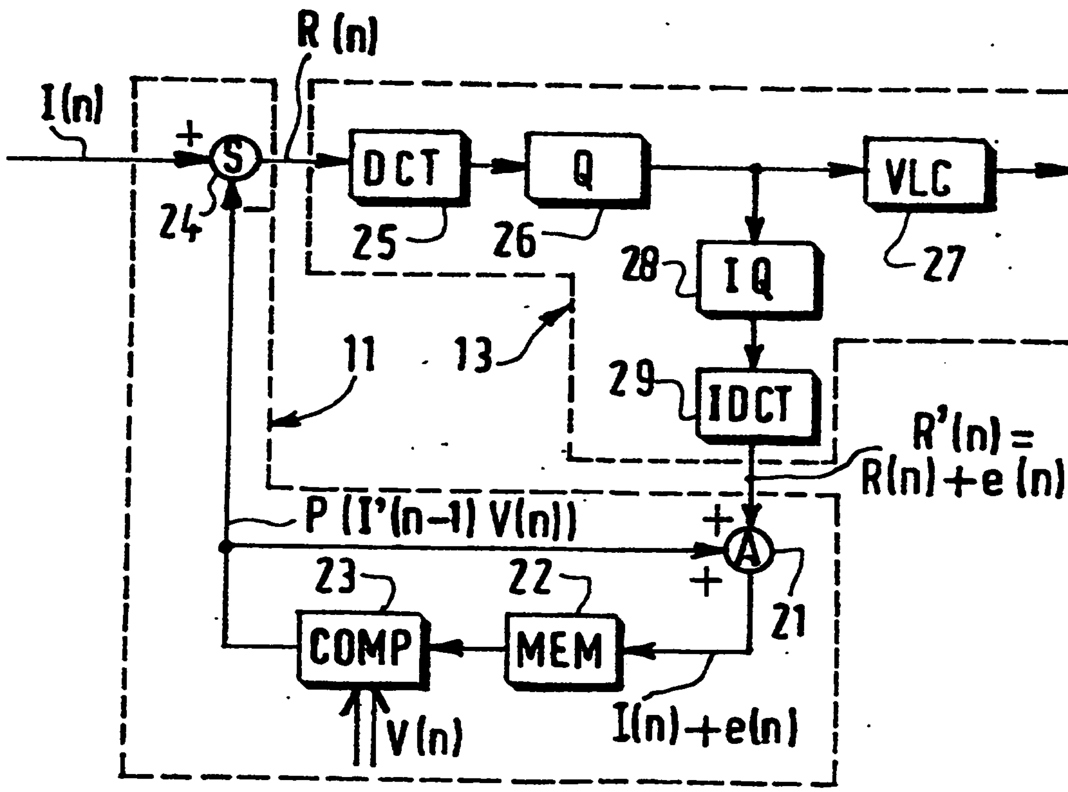

R (n)
I(n)
+
S
24
DCT
Q
VLC
25
26
27
28
IQ
29
IDCT
11
13
R'(n) =
R(n)+e (n)
P (I'(n–1) V(n))
+
+
A
21
23
22
COMP
MEM
V(n)
I(n)+e(n)

FIG.2

2/6

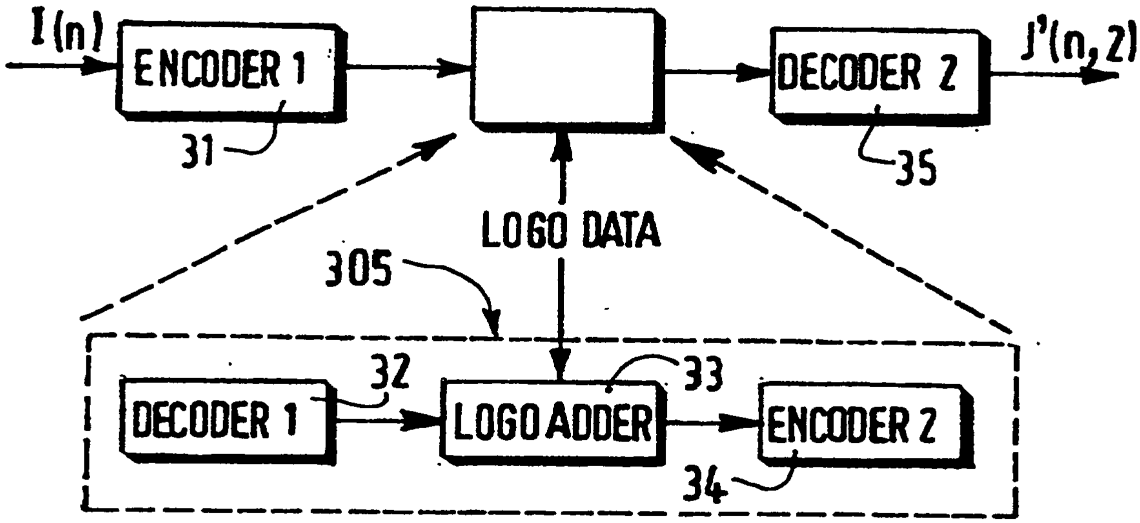

I(n)
ENCODER 1
31
DECODER 2
J'(n,2)
35
LOGO DATA
305
DECODER 1
32
LOGO ADDER
33
ENCODER 2
34

FIG.3

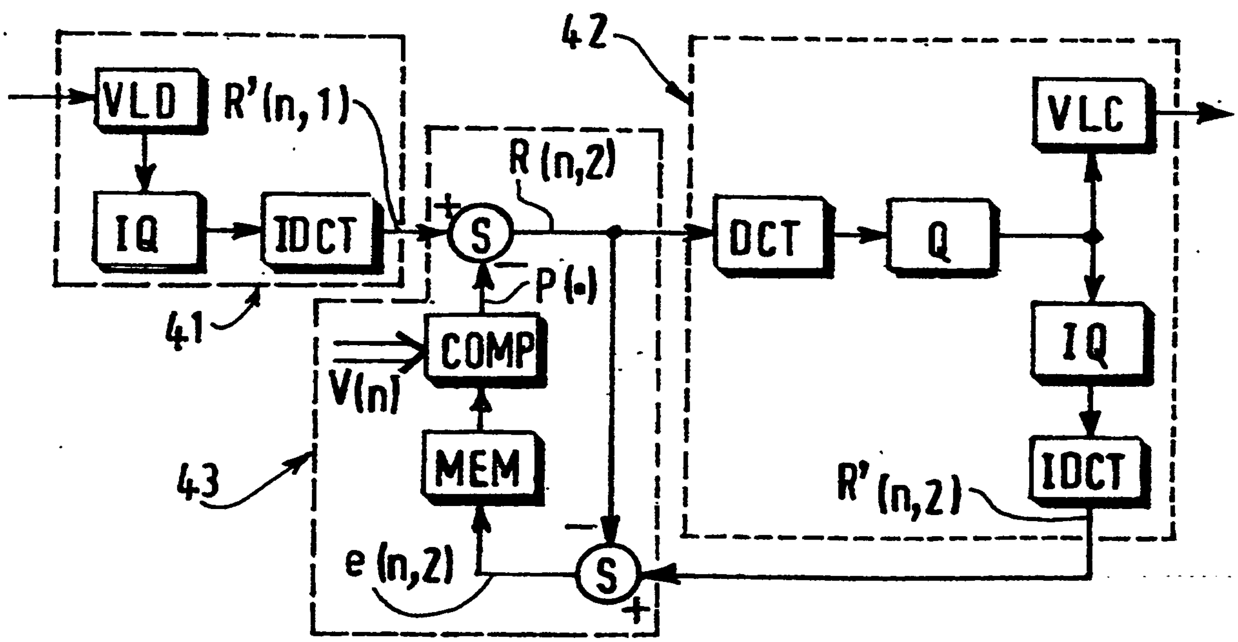

42
VLD
R'(n,1)
IQ
IDCT
41
R(n,2)
S
P(•)
COMP
V(n)
MEM
43
e(n,2)
S
DCT
Q
VLC
IQ
IDCT
R'(n,2)

FIG. 4

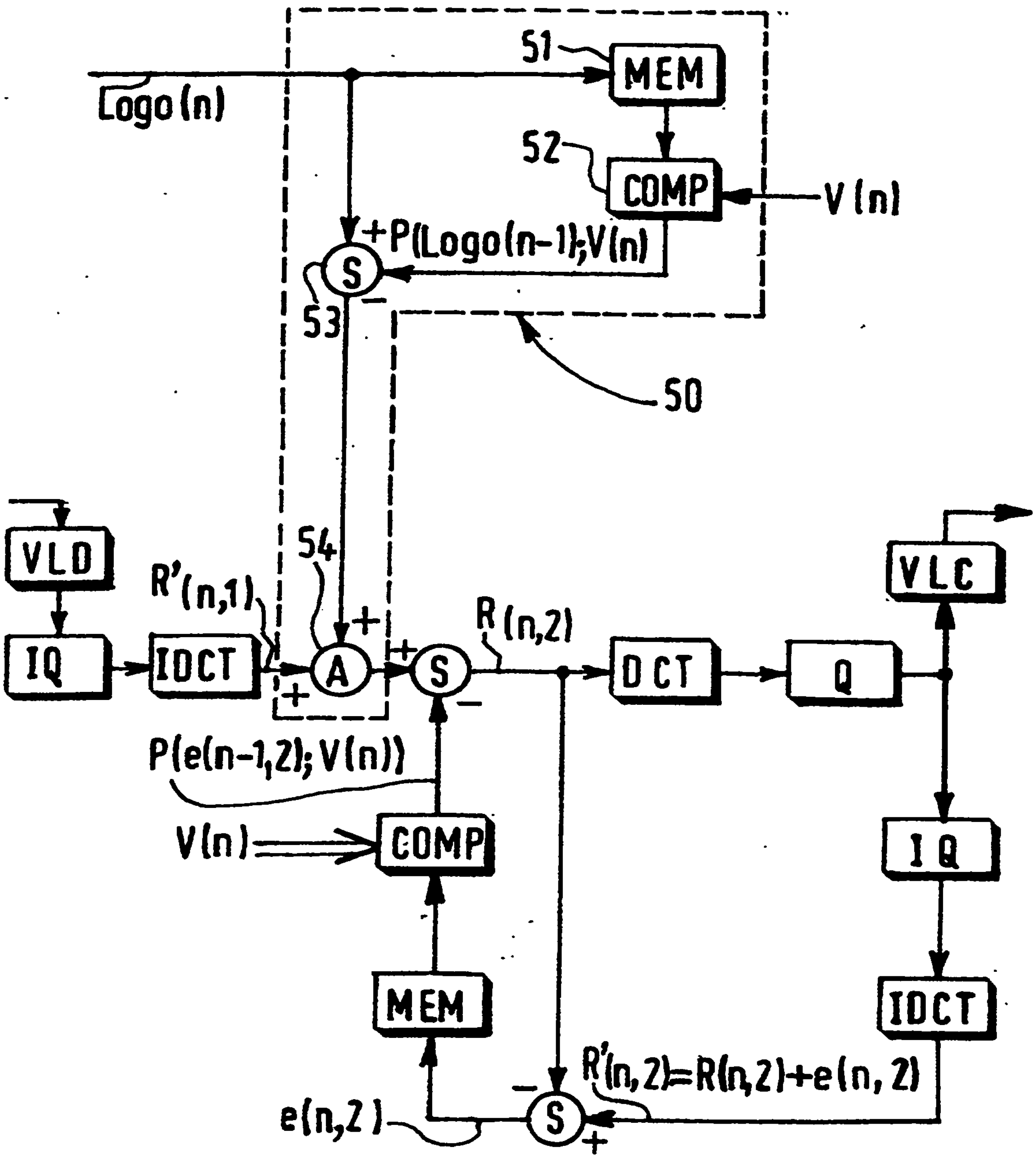
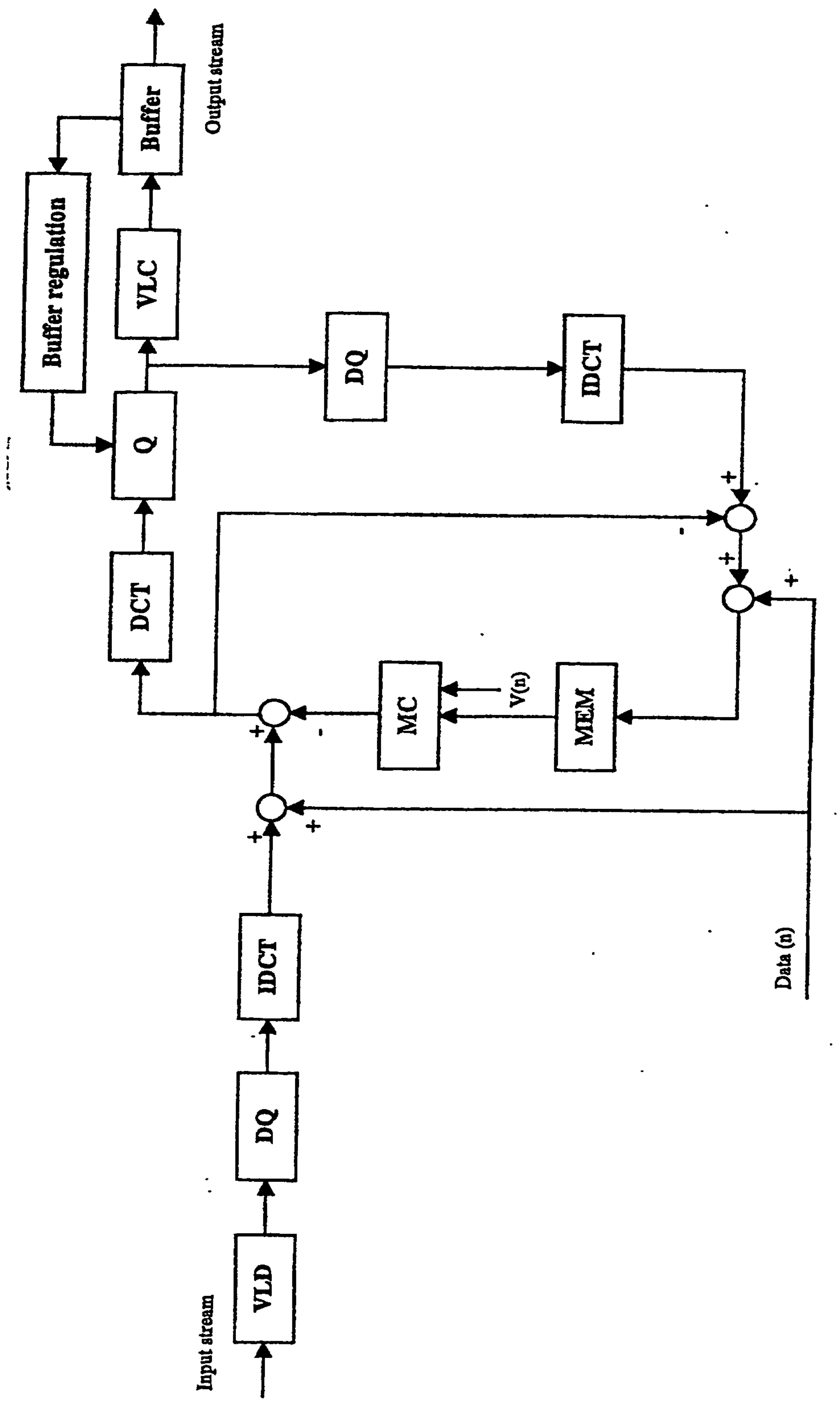

51
MEM
Logo(n)
52
COMP
V(n)
+P(Logo(n-1);V(n)
S
53
50
VLD
IQ
IDCT
R'(n,1)
54
A
S
R(n,2)
DCT
Q
VLC
P(e(n-1,2);V(n))
V(n)
COMP
IQ
MEM
IDCT
R'(n,2)=R(n,2)+e(n,2)
e(n,2)
S

FIG. 5

4/6



Input stream
VLD
DQ
IDCT
DCT
Q
VLC
Buffer
Output stream
Buffer regulation
DQ
IDCT
MC
V(n)
MEM
Data (n)
+
-

FIG. 6

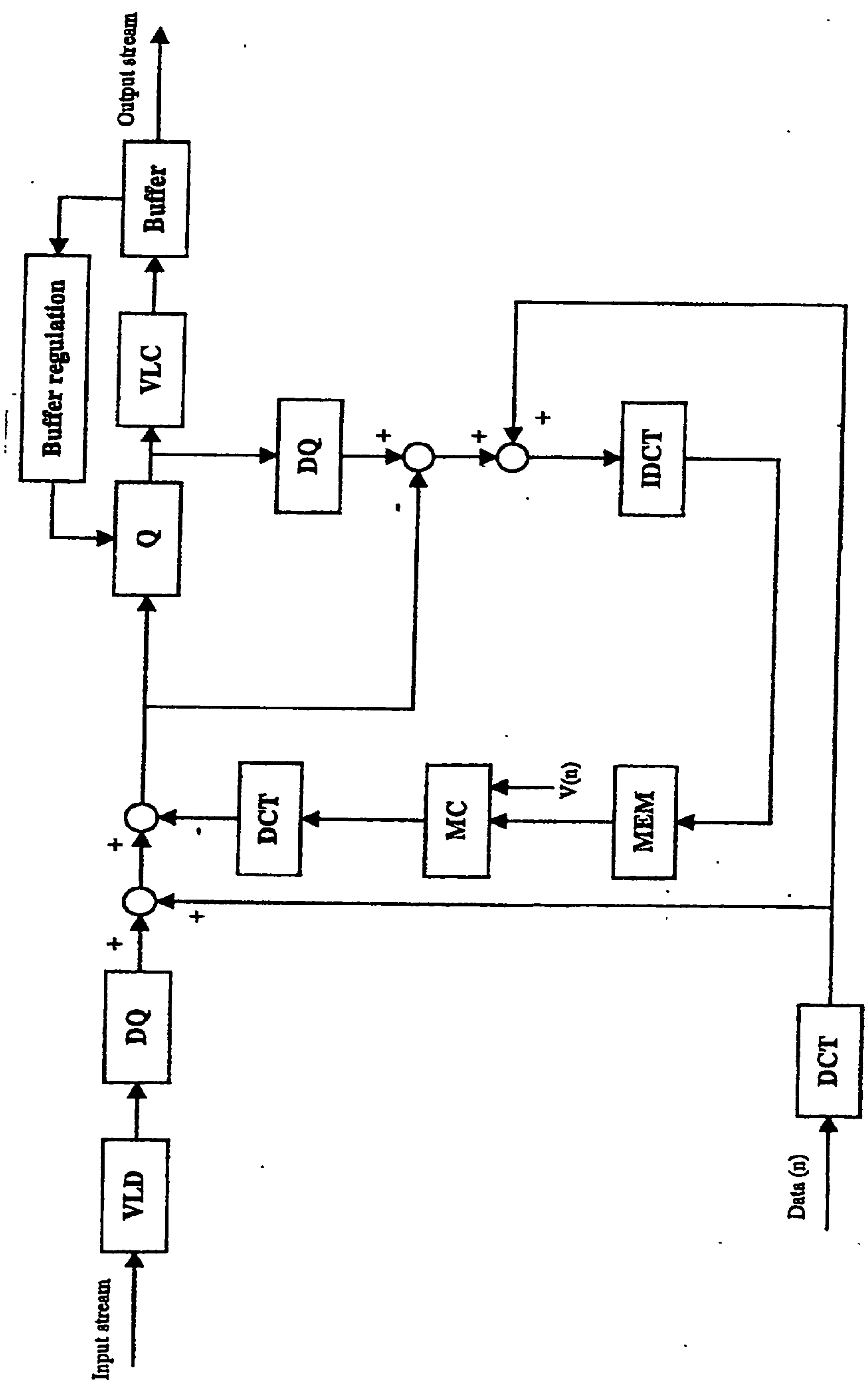

Input stream
VLD
DQ
DCT
MC
V(n)
MEM
Q
Buffer regulation
VLC
Buffer
Output stream
DQ
IDCT
DCT
Data (n)

FIG. 7

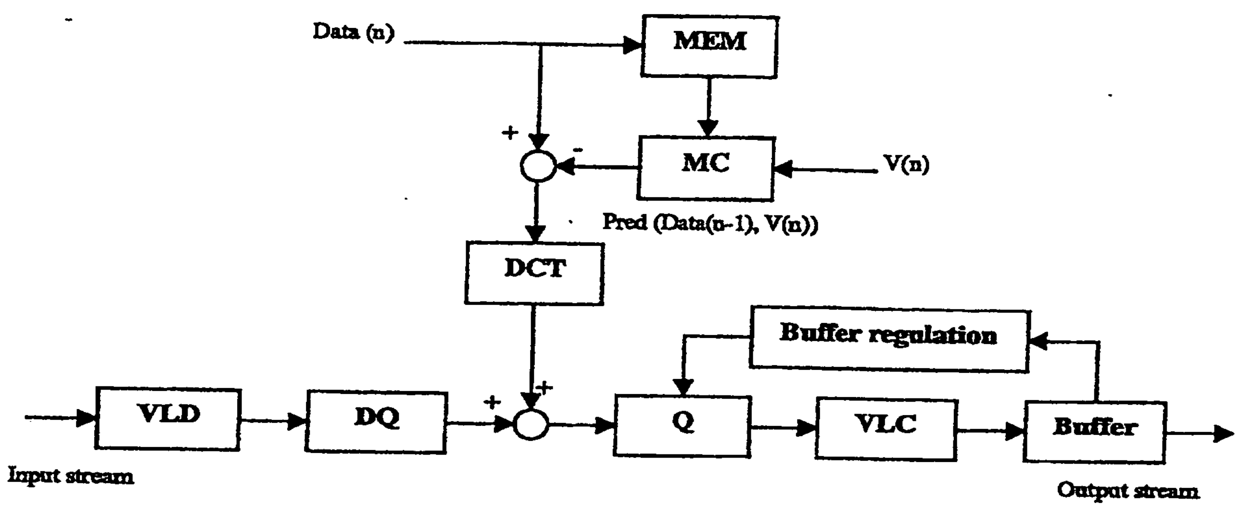

Data (n)
MEM
MC
V(n)
+
-
Pred (Data(n-1), V(n))
DCT
Buffer regulation
VLD
DQ
+
+
Q
VLC
Buffer
Input stream
Output stream

FIG. 8